

CLAIMS

What is claimed is:

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1. A process for producing sterols, said process comprising:
 - (a) providing a fatty acid production-residue, said residue comprising sterol esters, free fatty acids, and partial glycerides;
 - (b) removing the free fatty acids;
 - (c) transesterifying the partial glycerides with a lower alcohol in the presence of a basic catalyst under mild transesterification conditions to form fatty acid alkyl esters and glycerol;
 - (d) removing excess lower alcohol, the basic catalyst, the glycerol and the fatty acid alkyl esters, to form a bottom product comprising the sterol esters; and
 - (e) transesterifying the sterol esters at a temperature of from 115°C to 145°C and a pressure of from 2 to 10 bar for a period of from 3 to 10 hours to form free sterols.
 2. The process according to claim 1, wherein the fatty acid production-residue is vegetable oil-derived.
 3. The process according to claim 1, wherein the fatty acid production-residue comprises a residue derived from an oil selected from the group consisting of soybean oil, sunflower oil, rapeseed oil, coconut oil, palm oil, palm kernel oil, and mixtures thereof.
 4. The process according to claim 1, wherein removing the free fatty acids comprises neutralization, precipitation and separation.
 5. The process according to claim 4, wherein the free fatty acids are neutralized with a sodium metasilicate to form a precipitate, and the precipitate is separated by filtration.
 6. The process according to claim 1, wherein removing the free fatty acids comprises esterifying the free fatty acids with a lower monohydric alcohol to form free fatty acid-based fatty acid alkyl esters, and removing the free fatty acid-based fatty acid alkyl esters with the fatty acid alkyl esters formed in step (d).
 7. The process according to claim 1, wherein removing the free

fatty acids comprises esterifying the free fatty acids with a polyol to form polyol esters, and transesterifying the polyol esters along with the partial glycerides transesterified in step (c).

8. The process according to claim 7, wherein the polyol comprises glycerol and the free fatty acids are esterified to form free fatty acid-based partial glycerides, and the free fatty acid-based partial glycerides are transesterified along with the partial glycerides transesterified in step (c).

9. The process according to claim 8, wherein esterification of the free fatty acids with glycerol is carried out at a molar ratio of about 1:1, at a temperature of from 215°C to 230°C, and at a pressure below 1 bar.

10. The process according to claim 1, wherein the transesterification of the partial glycerides under mild conditions is carried out at a temperature of from 90°C to 145°C and a pressure of from 2 to 10 bar, for a period of from 2 to 20 minutes.

11. The process according to claim 1, wherein the transesterification of the partial glycerides under mild conditions is carried out at a temperature of from 90°C to 145°C and a pressure of from 3 to 5 bar, for a period of from 2 to 20 minutes.

12. The process according to claim 8, wherein the transesterification of the partial glycerides under mild conditions is carried out at a temperature of from 90°C to 145°C and a pressure of from 2 to 10 bar, for a period of from 2 to 20 minutes.

13. The process according to claim 8, wherein the transesterification of the partial glycerides under mild conditions is carried out at a temperature of from 90°C to 145°C and a pressure of from 3 to 5 bar, for a period of from 2 to 20 minutes.

14. The process according to claim 1, wherein the lower alcohol comprises methanol.

15. The process according to claim 1, wherein removing excess lower alcohol comprises allowing expansion until the reaction temperature has cooled to a temperature of from 65°C to 85°C.

16. The process according to claim 8, wherein the lower alcohol comprises methanol.

17. The process according to claim 8, wherein removing excess lower alcohol comprises allowing expansion until the reaction temperature has cooled to a temperature of from 65°C to 85°C.

18. The process according to claim 12, wherein the lower alcohol comprises methanol.

19. The process according to claim 12, wherein removing excess lower alcohol comprises allowing expansion until the reaction temperature has cooled to a temperature of from 65°C to 85°C.

20. The process according to claim 1, wherein the removal of the basic catalyst comprises the addition of an aqueous solution of an acid, precipitation of the catalyst and separation of the precipitate.

21. The process according to claim 1, wherein the fatty acid alkyl esters are removed by distillation.

22. The process according to claim 21, wherein the distillation is carried out at a temperature of from 170°C to 200°C and a pressure of from 1 to 5 mbar.

23. The process according to claim 14, wherein the fatty acid alkyl esters are removed by distillation.

24. The process according to claim 23, wherein the distillation is carried out at a temperature of from 170°C to 200°C and a pressure of from 1 to 5 mbar.

25. The process according to claim 16, wherein the fatty acid alkyl esters are removed by distillation.

26. The process according to claim 25, wherein the distillation is carried out at a temperature of from 170°C to 200°C and a pressure of from 1 to 5 mbar.

27. The process according to claim 18, wherein the fatty acid alkyl esters are removed by distillation.

28. The process according to claim 27, wherein the distillation is

carried out at a temperature of from 170°C to 200°C and a pressure of from 1 to 5 mbar.

29. The process according to claim 1, wherein the transesterification of the sterol esters is carried out at a temperature of from 120°C to 130°C and at a pressure of from 3 to 6 bar, for a period of from 4 to 8 hours.

30. The process according to claim 1, further comprising purification of the free sterols via crystallization and washing.

31. The process according to claim 1, further comprising subjecting the free sterols to droplet formation via melting, spraying through droplet-forming nozzles, and solidification via cooling with countercurrent airflow in a gravity tower, to form dust free spherical particles.

32. A process for producing sterols, said process comprising:

(a) providing a fatty acid production-residue derived from an oil selected from the group consisting of soybean oil, sunflower oil, rapeseed oil, coconut oil, palm oil, palm kernel oil, and mixtures thereof, said residue comprising sterol esters, free fatty acids, and partial glycerides;

(b) esterifying the free fatty acids with glycerol to form free fatty acid-based partial glycerides;

(c) transesterifying the partial glycerides and the free fatty acid-based partial glycerides with methanol in the presence of a basic catalyst at a temperature of from 90°C to 145°C and a pressure of from 2 to 10 bar, for a period of from 2 to 20 minutes, to form fatty acid methyl esters and glycerol;

(d) removing excess methanol, the basic catalyst, and the glycerol, and distilling off the fatty acid methyl esters at a temperature of from 170°C to 200°C and a pressure of from 1 to 5 mbar, to form a bottom product comprising the sterol esters; and

(e) transesterifying the sterol esters at a temperature of from 115°C to 145°C and a pressure of from 2 to 10 bar for a period of from 3 to 10 hours to form free sterols.